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ABSTRACT

The research on the demand for skills in the U.S. economy is split over the issue of whether technological change has tended to increase or decrease job skill requirements. The question of whether job skill requirements have been rising is important to public policy debates concerning the skill gap, wage inequality, and the changing quality of jobs. Some researchers have attempted to use indirect measures of skill requirements, whereas others have used direct measures and have concentrated primarily on case studies. Neither approach is free of problems, however. A far better data source is job analysis. The job analysis measure developed by Hay Associates is similar to the Dictionary of Occupational Titles (DOT) measure and includes a series of variables that capture the autonomy and complexity of jobs with respect to areas such as know-how, problem solving, and accountability. The Hay technique of job analyses was used to study the changing skill requirements for production and clerical jobs. The results suggested support for highly significant skill increases in production jobs. The results for clerical jobs, on the other hand, varied significantly by function. Half the clerical jobs examined experienced significant increases in skill needs, whereas the other half experienced significant decreases. Appendices contain data on the Hay technique, a list of production job titles, and graphical analyses of eight jobs. (Contains 83 references.) (MN)

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Are Skill Requirements Rising? Evidence from Production and Clerical Jobs

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Are Skill Requirements Rising? Evidence from Production and Clerical Jobs

The concept of skill reflects both the capacities and human capital that workers bring to jobs and the specific demands that individual jobs require from workers once they occupy those jobs. Whether the demand for skills is changing is a vitally important question for public policy. The answer can help determine the distribution of income, the extent of technological unemployment, and if there are skill shortages that may lead to a lack of competitiveness, especially in relation to other economies that have the valued skills in more abundance.

Factors Shaping the Demand for Skill

The demand for skill in the economy is derived from the objective requirements associated with jobs. Changes in the demand for skill in the economy are the result either of changes in the requirements associated with individual jobs or in the distribution of employment across jobs that have different skill requirements. An important theme in research on skill asks whether technology has an exogenous effect on skill requirements, and there is a long literature in the social sciences (most prominent in sociology) that argues that there is a natural trend in market economies with respect to skill requirements. One tradition argues that technological change has tended to increase skill requirements by eliminating noxious physical labor. The focus here is often on technological changes that are so massive and inexorable that their effects on employment can be treated as exogenous.[1] Another, and perhaps equally long tradition, sees technological change operating to reduce skill levels. These arguments often assert that industrialization and new technologies lead to "deskilling"—a reduction in the breadth of skills required from workers and, in particular, a reduction in their control over the way their jobs are performed.[2]

Especially in the 1970s, the "deskilling" research argued that the type of technologies used and the way they were implemented were choice variables that management could exercise in ways that depended on the circumstances. Marglin (1974), for example, argued that deskilling and the subsequent reduction in worker control was a conscious management decision taken to increase control over workers and make the management process easier.[3] This thesis reached its most popular form in the work of Braverman (1974), who placed the deskilling argument in a general Marxist framework and extended it to clerical and other nonproduction jobs.[4] The early 1970s represented perhaps the zenith of this approach as growing worker dissatisfaction with production jobs led to explicit public policy acknowledgements that narrow, deskilled jobs were part of the cause (e.g., *Work in America* [1973]).

The upskilling tradition tends to rely on forces external to the organization for its explanations and changes in the distribution of employment for evidence. The deskilling tradition relies on forces internal to the firm (i.e., management strategy) and changes within individual jobs for its explanations (see Attewell [1990] for a review).

The third literature area, more contemporary and empirically driven, asserts explicitly that technology and its implementation is a choice variable, but that the choice is not always to reduce skill. Spenner (1983) described this research as the "mixed effects" position in terms of the net change it predicts in skill.[5] This middle position appears a priori to be the most sensible, given that few technologies are so dominant that the decision to use them is independent of the costs of the associated labor, and it is clearly possible to implement the same technology in a variety of ways in response to factor prices such as wages.

The 1980s represent a particularly good period for examining changes in skill and the competing views noted above. Many observers believe that events such as the OPEC oil price shock in 1979, the recession in 1981, domestic deregulation of product markets, and the rise of foreign competition combined in this period to produce an exceptionally large amount of structural change in the U.S. economy (e.g., U.S. Congress [1984]). The decline of union power to resist changes (see Kochan, Katz, and McKersie [1985]) and the development of new workplace technologies, such as computer-aided design and manufacturing, gave management an unprecedented opportunity to react to these external pressures by restructuring work and employment relations.

A new set of studies examined changes in skill in this period and look beyond technology for their explanations. Piore and Sabel (1984) argue that the saturation and greater international competition of industrial markets has forced employers to find smaller market niches that demand quicker reactions to changing markets and, in turn, a more flexible workplace where jobs are defined more broadly and workers have greater control over them. The result is to create jobs with more skill, broadly defined. Cappelli and Sherer (1989) find a broadening of responsibilities in such a firm, and Loveman (1988) finds evidence of a shift in manufacturing occupations toward greater skill that is consistent with the "flexible-specialized" hypothesis.[6]

Public Policy Issues

Whether skill requirements have been changing has become an increasingly important issue for public policy because such changes relate to several public policy debates.

Skills Gap

The notion of a skills mismatch or a "skills gap" implies that there will be an increase in skill requirements that cannot be met by the current supply of skills. It is argued that the new equilibrium in the labor market that will be the result of this gap will have undesirable consequences for public policy, cause delays in filling positions, and catalyze either increased wages for skilled jobs that damage competitiveness or efforts to deskill jobs in order to increase the supply of applicants. *Workforce 2000* (U.S. Department of Labor 1987), focused the attention of both employers and policymakers on the issue of a potential mismatch between the skills of the labor force and the demands of employers in the years ahead. Complaints by employers of difficulties in finding workers with adequate basic skills, despite a plentiful supply of applicants, was one of the major forces that led to another Department of Labor investigation, the Secretary of Labor's Commission on *Workforce Quality and Labor Market Efficiency* (1989). A recent report by the Office of Technical Assessment (1990) also argues that there will be a mismatch between the existing labor force and skill requirements as manufacturing, in particular, shifts to the flexible-specialized production techniques described by Piore and Sabel (1984).

Most of these studies draw conclusions about skill requirements from projections concerning changes in the distribution of employment across occupations. These analyses assume that the skill requirements of individual jobs will remain constant in the future: if the distribution of employment shifts toward jobs that have higher skill requirements, then the workforce as a whole will experience upskilling. Whether changes in the distribution of jobs was leading to more low-wage, "bad" jobs (e.g., Bluestone and Harrison [1986]) or not (Kosters and Ross 1988) was one of the more hotly debated issues in the employment area. *Workforce 2000* (U.S. Department of Labor 1987), for example, argues that because those jobs with the fastest rates of growth have higher-than-average skill requirements, the overall workforce should experience upskilling. Mishel and Teixeira (1990) point out, however, that because these fast-growing jobs account for only a small proportion of all employment. the net effect on overall skill requirements will be small. Howell and Wolff (forthcoming) find that the rate of increase in skill requirements as a result of an upgrading of the occupational distribution. while still positive. has actually declined—and will do so through the year 2000—in contrast to the 1960s. This important research has helped redirect thinking about skill changes.

An important assumption in using the occupational distribution to examine skill requirements is that the skill levels of individual occupations will remain unchanged. A small shift in the composition of the workforce from technicians to engineers. for example. may not necessarily imply an overall increase in skill if technician jobs have been significantly upskilled and engineer jobs deskilled. Therefore. it is also important to know whether the requirements of individual jobs are changing.

Wage Inequality

If skill requirements rise. one should expect a new. higher equilibrium price to emerge for skilled labor. if other factors are equal. Changes in the wage premium associated with skill might therefore be interpreted as evidence of a change in skill requirements. The rise in the returns to education in the 1980s is well documented. especially for white men (Levy 1988; Katz and Revenga 1989; Bound and Johnson 1989; Blackburn. Bloom. and Freeman 1990; Murphy and Welch forthcoming). Wallace and Kalleberg (1982). Davis and Haltiwanger (1990). and Groshen (forthcoming) find rising wage differentials between occupations that suggest an increase in the premium for skill.

Many observers are inclined to view the rise of these wage differentials as evidence of increases in the demand for skill and of increases in skill requirements. But there are several difficulties with this interpretation. especially for the education differentials. Efforts to interpret changes in the "price" of skill confront the identification problem because the effects of changes in the supply of skill cannot be ruled out. at least not without examination. Blackburn. Bloom. and Freeman (1990) find. for example. that the decline in the baby boom and in college graduates contributed in the 1980s to rising wage differentials for college graduates.

Bishop (1989a) also reminds us that educational credentials may not be comparable directly over time: high school graduates in the 1970s had lower levels of knowledge and ability than graduates in prior decades. Where competency levels are declining. rises in wage differentials for education might. in part, reflect the need to secure workers with higher levels of education in order to maintain the same levels of competency.[7] The fact that there are at best very limited relationships between higher levels of competencies. as measured by test scores in high schools. and either placements or wages (see Bishop [1989b] for a review) suggests that the demand for "skill." at least as measured by higher levels of competency in school. may not be the dominant explanation for rising educational differentials.[8] It would also be important to know whether the rising wage differentials associated with skilled jobs could be attributable to changes in the supply of skilled workers. In short. wage changes may not be the ideal measure for assessing changes in the demand for skill.

Changing Quality of Jobs

Employers might be expected to respond to a relative "skills gap"—manifested as greater difficulty in hiring and/or higher wages—by substituting capital for labor and altering the production function by redesigning jobs to have lower skill requirements. This should expand the supply of applicants and address the relative shortage of skilled workers. but it also creates less challenging jobs that pay less. There is some recent evidence that employers are responding to higher wages and general difficulties in recruiting skilled workers by deskilling jobs.[9] Studies like the one by the Office of Technical Assessment (1990) present the worrisome possibility that the products of these deskilled production systems will not be of the quality necessary to compete internationally.

Direct Measures of Skill Requirements

There have been many attempts to use indirect measures of skill requirements. In addition to wage premiums, noted above, studies sometimes attempt to use measures of worker characteristics to assess whether skill requirements have changed. The problem with relying on measures of workers' credentials, skills, or human capital—defined broadly as measures of skill requirements—is that there is considerable evidence that such worker characteristics vary independently from the demands of jobs (e.g., Berg [1970]). Most of the research that has examined skill requirements directly consists of case studies, some of which were described in the context of technology studies above. While such studies greatly advance our understanding about why changes in skill occur and how they take place, it is difficult to generalize from them to the economy as a whole. One reason is that the studies themselves often suggest that the results depend on the context (the type of technology, conditions in the economy and labor market, the distribution of power in the workplace, etc.), which implies that the historical studies, in particular, may not generalize well to other periods or situations. There also appears to be a significant selection bias in many of these studies as they appear to have been selected in many cases because something unusual was happening.

These difficulties suggest that aggregate data are needed to examine whether skill levels are changing, but finding an adequate source for such data is difficult. What one wants from a measure of skill is an understanding of how the job is performed, and that may be difficult to convey with a single-item, unidimensional measure. Jobs with similar educational requirements, for example, can be very different, especially when those requirements are framed in terms of general credentials, such as having a high school degree. Psychologists who study job design tend to be interested in the relationship between jobs and individual needs, so they often focus on aspects of jobs that are associated with those needs, such as autonomy and variety (e.g., Hackman and Oldham [1975]). Sociologists focus more on aspects such as autonomy and complexity because of their interests in issues, such as power, control, and relations between workers and management (Form 1987; Spenner 1983, 1990), and these have been the central concepts in research on skill requirements. In order to test these theories, a good data source should provide multiple measures of job characteristics that capture aspects of autonomy, variety, and complexity in jobs.

One approach for obtaining such data is to ask workers directly about the requirements of their jobs (Mueller et. al. 1969), but self-reports of job characteristics are problematic because it is well-known in the psychology literature that an individual's perceptions of job characteristics do not necessarily relate well to actual job characteristics (see Roberts and Glick [1981]). Myles and Eno (1989) found that workers' self-reports of skill requirements in the jobs differed substantially from those provided by expert raters. An accurate proxy for skill changes must focus on the characteristics of jobs.

The most popular data source for measuring the skill requirements of jobs is the U.S. Department of Labor's *Dictionary of Occupational Titles* (DOT), now in its fourth edition, which is compiled by government job analysts who provide detailed descriptions of some 12,000 job titles. By examining changes in these titles in subsequent editions, one can measure changes in job requirements (Horowitz and Herrnstadt 1966; Spenner 1979). But there may be serious problems associated with using the DOT in this manner. As Cain and Treiman (1981) report, it is not clear that all of the entries were actually reanalyzed in subsequent editions, and there may have been a bias toward making the reports consistent over time. Further, by itself the DOT measure only tells what is happening to the content of specific jobs, not what is happening to average skill across a workforce or an organization. For example, it is quite possible for a given job such as drafting to be substantially deskilled by new technology while at the same time the composition of the design workforce in a firm shifts from drafting jobs to higher-skilled engineering jobs. The overall skill level of the design function may rise because of this shift in its composition, even though the skill associated with individual jobs is declining. Spenner (1990) offers a review of research and issues associated with the DOT.

An alternative approach is to estimate skill changes by examining shifts in the composition of occupations in the economy, the approach followed by *Workforce 2000* (U.S. Department of Labor 1987) and discussed earlier. Perhaps the best data source for compositional studies is the *Occupational Employment Statistics Survey* assembled by the Bureau of Labor Statistics (BLS). This survey examines 150 occupations in each industry with establishment-level surveys and reports the shift in employment across those occupations.[10] The problem with this survey, as with all of the compositional studies, is the difficulty in controlling for the content of jobs. Although the interviewers are provided with common definitions of job titles, it is not obvious that the respondents are really using common definitions and that the results are reliable. For instance, if an establishment refers to a position as "accountant," it is heavily biased toward reporting that as the title, even if the position more accurately fits the interviewer's definition of "bookkeeper."

Problems of reliability can also arise within the same establishment over time. Perhaps the most important problem is that job titles do not always accurately reflect changes in skill requirements. Job requirements may escalate or decline slowly and incrementally before changes become noticeable. Even then, formal adjustments in titles may occur only in the context of a complete job reevaluation for the entire organization, something that may occur only once in several years. Similarly, employees in less rigid organizations are sometimes rewarded with "promotions" and given higher job titles, even though their duties remain unchanged. In addition to the prestige of higher titles, line managers may arrange such promotions to secure grade-based salary increases, especially when general salary increases are being restrained. The practice is sometimes known in the compensation literature as "grade drift."[11]

Finally, compositional studies do not indicate whether there are changes in skill requirements within individual jobs, which is the reverse of the problem noted above in using the DOT. For example, the decline in aggregate skill levels associated with a shift in workforce composition from quality control to assembly jobs may be offset if there has been substantial upskilling of assembly jobs.

Spenner (1983) reviewed the research that is based on aggregate data, generally the DOT and workforce composition studies and concluded that the results have been mixed: perhaps small upgrading of content in the form of complexity, equivocal results for content in the form of autonomy, and not much change in composition. His conclusions suggest that "the poverty of quality data" (Spenner 1983, 83) may be the main issue facing better estimates of skill changes.

The data concerns raised above can be used to develop criteria for appropriate skill data.

1. The data should focus on actual job characteristics and not proxies, such as worker characteristics.
2. The measure of skill should measure the autonomy and complexity of jobs.
3. The skill measure should be consistent and reliable across establishments and over time.
4. The sample should be constant over time to reduce confounding effects.
5. The data should capture both changes in content (within jobs) and in composition (across jobs). The data, therefore, should not be limited to individual jobs but ideally should examine sets of jobs—workforces—across which substitutions can occur.

An Alternative Data Source

This research centers on a new data source for measuring skill changes that represents a substantial improvement over existing sources and appears to meet most of the criteria above. The data come from Hay Associates, the world's largest compensation consulting firm. Hay performs a job analysis (identifies the job requirements) for its clients and then establishes what other clients are paying for jobs with identical content. In the process, Hay collects data on jobs and their characteristics that allow an assessment of skill changes to be made over time.

The measure of skill used by Hay is similar to the DOT measure and includes a series of variables that capture the autonomy and complexity of jobs (Appendix A). The submeasures are grouped into three classifications: "Know How," which measures the capabilities, knowledge, and techniques needed to do the job ranked according to their complexity: "Problem-Solving," which measures how well-defined and predictable job tasks are; and "Accountability," which measures autonomy in decision making. These measures get at the autonomy-complexity dimension of skill that concerns fields such as psychology and sociology. (The Hay system is described in detail in Bellak [1984].) There is considerable debate about the validity of any measure of skill—whether it should capture abstract intelligence, physical and social interactions, or specific employer requirements (see Levin and Rumberger [1990] for a summary)—but the Hay measure appears to be at least as valid a measure as any others proposed. Further, the Hay measures have widespread influence on jobs in the economy as a whole and, in that sense, have good external validity. This system is used for over 2 million jobs in the United States, including those positions for most of the country's largest corporations, and comparisons by non-Hay firms with these establishments extend the influence of the Hay system even further.

The Hay measures also appear to be reliable. They have been constant at Hay for decades and, more important, are applied consistently across establishments. Hay staff receive considerable training in applying the measures, they visit the clients, and conduct the job analysis on the jobs being examined: the results are then checked for reliability by a central office.[12] Indeed, the product that Hay ultimately sells its clients is the assurance that its information is comparable over time and across organizations.[13] The first three criteria for data outlined above—*focusing on actual job characteristics, capturing autonomy and complexity, remaining reliable and consistent over time*—appear to have been met. The various skill measures are then combined into a single measure, the job evaluation score, which represents an aggregate assessment of the demands associated with the job.[14] Comparison of the skill scores over time will make it possible to estimate changes in skill.

Hay has complete records of the job analyses since 1978 for 94 production job titles across a sample of 93 manufacturing establishments in 27 U.S. communities. The jobs in the sample represent 56,536 workers. The communities include all regions of the United States and a mix of rural and urban areas, although the geographic distribution of the sample was not designed to be representative of the United States as a whole. The firms in the sample were selected in order to help establish the labor market conditions for production work in each of the communities. The sample is therefore weighted toward larger establishments because they employ a disproportionate percentage of the labor force. The average establishment in the sample has 608 production employees. Schmenner (1984) reports that the average manufacturing plant operating in the United States in 1979 had 644 workers, so the size of the operations in the Hay survey may not be unrepresentative of the national population even though they may be among the larger establishments in their communities. The sample is distributed across industries and product lines in manufacturing. The firms in the sample are not necessarily Hay clients, although they do receive information from the survey in return for their participation. The fact that this data set is for manufacturing is particularly important, given that most of the literature on skill requirements focuses on manufacturing jobs.

The 94 production job titles span the full range of nonexempt, production work that is found typically in manufacturing facilities (see Appendix B for the complete list). Hay consultants match jobs with titles to ensure that they are substantively identical across establishments. The jobs are then reevaluated each year. Because each job title corresponds to a unique job evaluation score (or a very narrow range of scores), positions in which skill has been substantially changed over time are retitled. For example, if an "Assembly 5" job has been upskilled, it becomes an "Assembly 6" job. It is therefore possible to examine both changes in skill content and skill composition by examining the changes in the distribution of job titles within general families of jobs. There are 10 job families that identify general functions or operations within the production process. For example, there are 14 separate assembly job titles within the general job family of "assembly operations" (see Appendix B), and by examining the distribution of assembly workers across those titles over time, we can see to what extent assembly operations have been upskilled or deskilled. (This approach is similar to Keefe's [1991] interesting study of machinists, which examines changes in the distribution of employment across machinist job titles with the Bureau of Labor Statistic's *Industry Wage Surveys* to examine the effects of numerically controlled machines on skills.) We can also look at the distribution of employees across job families to identify the extent to which changes in the composition of the workforce—shifts from high-skill to low-skill families, for example—have led to overall skill level changes for the workforce as a whole.

One important advantage of this Hay data is that because the job definitions are narrow and rigid, virtually all significant changes in skill requirements show up as measurable changes in job titles. This is in contrast to more broadly defined jobs, which may experience significant upskilling or deskilling before a title change occurs, severely censoring estimates of changes in skill and biasing estimates of skill changes. A related advantage of the Hay data is that it examines the entire range of production jobs in manufacturing operations, making it possible to reach conclusions about skill changes in manufacturing production work as a whole.

Clerical Skill Requirements

While most of the interest and research on skill requirements focuses on manufacturing firms and on production jobs in those firms, there has been a parallel literature that examines changes in skill demands for clerical jobs. This research is associated with the introduction of data processing technology (e.g., Freedman [1965]) and more recently with the rise of equipment that integrates functions—the automated office (see Guiliano [1982]). The divisions in research on clerical jobs are very similar to those noted above concerning production work. Scholars such as Glenn and Feldberg (1982) and Crompton and Reid (1982) follow in the Braverman tradition of arguing that clerical jobs have been deskilled, while Attewell (1982) and others suggest that the clerical function as a whole has experienced an increase in skill. These differences often appear in analyses of the same industries (especially insurance) and turn largely on how broadly the analysis is cast—the scope of the jobs examined and what gets included in the definition of "skill."

Hay has collected clerical job data that are similar to the production data described above. Their clerical survey examines 211 firms, located in nine different geographic regions, in jobs covering 68,058 employees. The 1978 survey was repeated in 1988. The job titles in this survey represent a range of clerical functions (excluding supervisory functions). Again, the firms are selected to help estimate average conditions in the labor market, so there is some bias toward examining larger organizations (the average firm in this sample has 322 clerical employees). The firms represent a cross-section of industries, but there was no effort to mirror the population of all firms. Because clerical tasks differ considerably across industries, the survey cannot be said to track developments across the entire set of clerical functions the way that the production survey covers the production process in manufacturing. Further, the nine regions are all urban areas, and no claim is made to generalize the results to the country as a whole. As with the production data, each of the nine job families can be seen as representing a discrete clerical function. Changes in the distribution of employment across job titles within that function suggests whether average skill levels have risen or fallen.

Drawbacks to the Data

For reasons of confidentiality, Hay Associates will not release information about the characteristics of the individual companies in these surveys, nor are the responses identified by company. The data presented below are aggregates across all establishments in the surveys. It is also impossible to disaggregate the overall job evaluation scores into their subcomponents—that is, to see what proportion of overall skill changes can be attributed to changes in autonomy, know-how, or responsibility. Further, information about establishments that dropped out of the survey before the end of the periods is not available. The data are, therefore, censored, and it is impossible to tell whether, for example, establishments that began after 1978 or those that failed before the end of the surveys ("births" and "deaths") have different skill levels than those that were in operation since 1978. In other words, it is possible that the firms in this sample are different from those that were born or died during the period of the study. Leonard and Jacobson (1990) concluded, however, that births and deaths of establishments in a similar period had no effect on the distribution of earnings within a sample of firms—earnings were not different for firms existing throughout the period. Given that changes in the distribution of skill should change the distribution of earnings, their conclusion that births and deaths did not affect the distribution of earnings might be difficult to sustain if jobs and skill requirements in these births and deaths were substantially different from surviving firms.

Analyses with the Hay Data

Hay Associates has made available the data on production jobs for the years 1978 and 198' .rd for clerical jobs for 1978 and 1988. This covers the period noted above that many believe experienced significant restructuring in the economy and the workplace. The most important use of this data is simply to see if there have been changes in skill levels as measured by Hay's job evaluation scores.

Distributions such as those of employees across job titles have many different aspects, and, as a result, there are many different ways to compare them. Perhaps the simplest comparison is whether the means are different—in this case, whether the average job in a job family has a higher or lower evaluation score than in the past. Simple analysis of variance and difference of means tests can be used to address this question but rely on the assumption that the underlying populations being sampled have a normal distribution.

It may be difficult to argue that jobs are distributed normally across titles within these job families. The distributions are shaped by firm production functions, and there is no reason to believe that they will be normal. Indeed, there may be a presumption that the distribution is sharply skewed—with many workers filling the routine, unskilled jobs and a handful of workers in the more cr 'ive, demanding jobs—associated with the pyramid shape of most organizational charts. Nonparametric methods for estimating differences in locations are more appropriate here because they do not rely on the assumption of a normal distribution. These include Wilcoxon two-sample tests, which compare differences in ranks between the two samples, and two-sample median tests, which compare the number of observations above a common median in the two samples.

If the sample was a true paired replicate—that is, each job was examined in 1978 and again in the later period—a Wilcoxon signed rank test would be the appropriate method. But it is impossible to conduct a paired-replicant test because the data are not identified by individual firm. The advantage of the two-sample test is that it can be used to examine two samples from different populations: the two samples do not have to be of equal size. As with some parametric statistics, the two-sample test may not be accurate if the two samples differ in dispersion. A dispersion test, such as Ansari-Bradley, should be used to examine that possibility. The appropriate nonparametric estimator of the size of differences in location between samples is the Hodges-Lehmann estimator, which finds the median of the ranked set of ordered differences between the two samples. Both tests are computationally difficult with data sets of this size—requiring $56{,}536^2$ separate calculations in the case of the manufacturing data, for example. Simpler dispersion tests discussed in another context below suggest that the dispersion in the two periods is virtually identical. See Hollander and Wolfe (1973) for a guide to these nonparametric statistics.[15]

Results

Table 1 provides a summary of the data and results. The first column identifies the job families for both production and clerical jobs. The second and third columns provide standard outputs for parametric statistics, analysis of variance and difference of means, respectively, for the 1978 and 1986 data (1988 for clerical jobs). The means are the average job evaluation points for jobs in each job family: higher scores in 1986 suggest upskilling within the job family. Sample sizes are reported in the fourth column along with the change in size over the period, which indicates changes in the composition of the workforce across job families. The last two columns report the results of nonparametric tests. The Z scores are ratios of the rank of the Y observations to its standard error.

The results suggest support for highly significant upskilling of production jobs, with the exception of the "Housekeeping" family (janitor-type functions). Some of the changes are quite large, as with "Inspection/Quality Control" and "Material Handling." Similarly, some of the changes in the composition of the workforce are also sizable. The sharp decline in "Quality Control" and "Material Handling" (inventory) jobs, for example, may be the result of job redesign efforts that try to incorporate these functions into other jobs. It could be that the functions that remain for workers

Table 1
Change in Skill, 1978-1986

	(1) ANOVA				(2) Difference of Means			(3) n		(4) Wilcoxin 2-sample		(5) Median 2-sample	
	Among MS	Within MS	F	Prob>F	(1978) X	(1986) Y	Prob>T	(1978) N	Δ	Z	Prob>Z	Z	Prob>Z
Assembly Operations	100488	196.2	214.2	0.0001	104	108	↑0.0000	17203	103	19.1	0.0000	20.4	0.0000
Electrical Work	22891	636	36	0.0001	245	250	↑0.0001	2060	-347	6.7	0.0000	7.4	0.0000
Housekeeping	2654	105	25	0.0001	103	102	↓0.0001	6819	-4211	8.2	0.0000	1.7	0.08
Inspection/Quality Control	362937	876	113.9	0.0001	115	128	↑0.0001	5216	-1595	23.9	0.0000	20.2	0.0000
Machine Repair and Maintenance	369866	1130	327	0.0001	213	226	↑0.0001	4736	576	15.9	0.0000	14	0.0000
Machine Operations	33887	1635	20	0.0001	143	147	↑0.0001	4492	112	5.3	0.0000	3.9	0.0001
Material Handling	123883	16125	24	0.0001	169	193	↑0.0001	4170	-510	6.9	0.0000	3.8	0.0001
Processing Operations	164830	828	199	0.0001	129	135	↑0.0001	8580	-673	15.2	0.0000	12.8	0.0000
Stockkeeping	2979	195	15.2	0.0001	123	125	↑0.0001	1872	-151	4.6	0.0000	2.7	0.006
Tool and Die Work	7491	278	26.9	0.0001	259	262	↑0.0001	1358	652	6.7	0.0000	1.6	0.10
Change in Skill, 1978-1988													
Clerical Jobs													
Bank Tellers	113467	1008	112.5	0.0001	155	161	↑0.0001	6801	217	13.5	0.0000	14.4	0.0000
Clerks	212189	938	226	0.0001	125	131	↑0.0001	16773	-3661	36.3	0.0000	7.3	0.0000
Typists	37565	395	95	0.0001	117	113	↓0.0001	9610	-5391	17.9	0.0000	30.8	0.0000
Clerical Support	122102	1107	110	0.0001	172	176	↑0.0001	20220	-1112	10.6	0.0000	10.5	0.0000
Computer Support	239529	3107	77	0.0001	166	157	↓0.0001	7209	-1028	7.57	0.0000	16.78	0.0000
Customer Service	5075	241	210	0.0001	141	159	↑0.0001	170	220	14.0	0.0000	99.9	0.0000
Office Equipment	166113	378	139	0.0001	111	90	↓0.0001	940	-313	11.9	0.0000	8.7	0.0000
Telephone Operators	125743	109	1149	0.0001	108	95	↓0.0001	1567	-143	19	0.0000	7.2	0.0000

in quality control have become more highly skilled as a result of transferring the more routine quality functions to other jobs. The rise of "just-in-time" inventory systems, which push some of the material handling functions off to suppliers, may have had a similar effect on jobs in that family. "Housekeeping," which was not a highly-skilled position to begin with, experienced a huge decline in employment, but little change in its skill level, perhaps because there was not much skill variance in its tasks—not much difference between what was transferred by job redesign to workers in other functions and what remained.

Because the Hay data identify all production jobs in manufacturing, it is possible to draw some conclusions about what has happened to skill levels across the entire production function. The average production job in 1986 had 6.7 more points than in 1978 (i.e., using 1978 employment as the base). On the other hand, the average *worker* in this sample was in a job in 1986 that was 7.4 points higher than the job held by the average worker in 1978 (i.e., using 1986 employment as the base). This difference is the result of a slight shift in the composition of the workforce toward job families that had larger increases in points. To put these figures in perspective, they represent almost half of the range of job titles within the largest job family ("Assembly"); it is as if every worker moved in skill level from the bottom of jobs in their function halfway to the top. We know that under this pay system wages are closely related to job points, and growth in points should be closely related to growth in wages. The other interesting conclusion looking across job families, therefore, is that employment growth was slowest where wage growth (upskilling) was highest.

The results for clerical jobs vary significantly by function. Half of clerical jobs experienced significant upskilling and the other half had significant deskilling. New office technologies that vary by job function seem to explain the variance. The biggest declines in skill are for office equipment and telephone operators. The replacement of duplicating machines with more "user-friendly" xerography equipment, which is typically serviced by outside vendors, probably contributed both to the decline of skill and employment for office equipment operators; PBX/automated switchboards had the same effect on telephone operators. The skill levels of typists have apparently declined with the introduction of word processors; the rapid decline in the number of typists no doubt reflects the widespread use of word processors by those workers who were previously supported by typists.[10]

Upskilling, on the other hand, does not seem as clearly associated with the introduction of new technologies. The sharpest upskilling is for customer service jobs, which may relate to new business strategies that demand higher levels of service (e.g., solving problems, providing a wider range of services) at the point of customer contact without passing the issues on to the bureaucracy. The exception may be bank tellers, where the shift of their more routine functions to automated teller machines has left them with a higher level of average tasks. The fact that ledger software has automated some of the simpler functions that were once performed by clerks may have contributed to the decline in their numbers, but may also have left them with a higher average level of tasks. On balance, technological changes may have contributed to the deskilling of the clerical function.

It is harder to draw conclusions from overall estimates of changes in the distribution of skill requirements for clerical jobs, because unlike the production survey, not all clerical job functions are included in this survey, and few organizations are likely to have all the clerical functions listed here. Bearing in mind those caveats, the average job in the clerical survey rose only 1.2 points over the decade, while the average clerical worker in 1988 had a job 1.9 points higher than in 1978. The modest shift in employment toward higher-skilled functions resulted from the fact that the jobs being deskilled suffered the greatest job losses.

Measures of Dispersion

In addition to knowing what has happened to average skill requirements, it is interesting to see whether the dispersion of employment across jobs and skill requirements has changed. For example, has the average gone up because all jobs have experienced a growth in skill, or do some smaller group of jobs account for the change? This is especially important given the studies noted earlier, which find an increase in wage inequality across skill levels: Is this driven by an increase in inequality of skill requirements? The dispersion in employment across all production jobs is compared in the two periods using the most popular measures of dispersion—variance, Gini coefficient, and Theil's inequality measure. Clerical jobs do not form a coherent hierarchy in which changes in dispersion can be clearly examined. The results reported in Table 2 suggest that the dispersion is virtually unchanged in the latter period.

Table 2 Equality of Skill Levels, 1978-1986	All Production Jobs	
	1978	1986
Mean Hay Points	132	138
Variance	2378	2894
Theil Entropy	.0242	.0254
Gini Coefficient	.1757	.1725

How does this result square with the studies that find increasing wage inequality? An increase in the inequality of skill requirements would be sufficient, other things being equal, to produce an increase in wage inequality, but it is not a necessary condition for producing greater wage inequality. Changes in relative wages result from the mapping of the demand for skill on its supply. For example, an upward shift of the entire distribution of skill requirements would mean that there is much less demand for jobs that were at the very bottom of the previous skill distribution; wages for such jobs should fall sharply and wage inequality should rise.[17] Indeed, the studies that find the growing wage inequality cited above generally conclude that this inequality is produced largely as the result of sharp declines in wages for the least educated/lowest-skilled workers.

Conclusions

The issue of changing skill levels has suffered from a surplus of theoretical arguments and a shortage of reliable data. The data presented above provide a unique natural experiment for examining changes in skill levels. For production jobs, they suggest strong evidence of upskilling in job requirements combined with some tendency to shift the composition of employment toward job families with greater skill growth. Clerical jobs also show significant changes, although the pattern seems driven at the job family level by technological change.

One component that is missing from the above discussion is an analysis as to why these changes have taken the form that they have. It is difficult to explain the developments that led to these aggregate changes where data are not available below the aggregate level. It would be easier to provide explanations if skill patterns could be identified for individual firms and matched to characteristics of those firms. Any explanation must therefore be tentative.

The production jobs examined here are typically found only in large manufacturing operations, and they tend to function in an integrated fashion with other jobs, contributing to a common product. Where these firms are unionized, which occurs in about half of all manufacturing operations in this period, all production jobs tend to be covered by a common union contract, often contracts that are common across many companies. As Keefe (1991) concludes, the main technological innovation in production work—numerically controlled machines—have played a relatively minor role in changing the way jobs are performed. Changes in production jobs seem much more driven by developments in traditional employee relations areas—new management views concerning how jobs should be redesigned and the decline of union power that made their implementation possible. These developments have been system-wide and may have produced similar changes across all job families. For example, the contemporary effort to make all jobs in a production firm responsible for quality—total quality management—adds some inspection functions to all other job families and raises their skill level.

Clerical jobs, on the other hand, occur in virtually all operations. The jobs tend to be performed with considerable autonomy: the work performed by telephone operators will not necessarily come in contact with the work performed by bookkeepers. Each of these jobs also tends to have its own identifiable external labor market. The standardizing effects of unionization were never much of a factor for these jobs. New theories of how to organize jobs may have had some effect on clerical job demands, especially on customer service, but many of these jobs are performed idiosyncratically (such as secretarial work) and do not lend themselves easily to traditional job redesign efforts. The important developments in clerical work over the last decade appear to have been the introduction of new technology. Word processors and personal computers were not invented in 1978 when this survey began. The new clerical equipment was different and separate for each function, and because these functions are performed autonomously in separate labor markets, the effects of the various new clerical technologies were different for each job function and family.

The fact that the upskilling of manufacturing jobs took place despite the findings from other studies of rising wage differentials for skill—that is, requirements rose even as prices were rising—suggests that the upskilling could not have been simply a response to a decline in the relative price of skill (i.e., a movement along the demand function for skill) and must represent a shift in the demand for skill. This conclusion runs counter to the deskilling hypothesis and is consistent with hypotheses that suggest that either changes in the 1980s—in product markets, technology, management strategy—increased the demand for skill.

Appendices for this paper can be obtained by calling the Education Line, 1-800-437-9799, or by writing to the Center:

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Endnotes

[1] Some of these arguments can be traced to Adam Smith (1776). Arguments about the benefits to workers of technology began with the scientific socialists and continued, for example, in studies of economic development, especially in comparisons between jobs in industrialized and developing countries. Kerr and coworkers (1960), for example, saw industrialization as liberating production workers from oppressive physical labor and leading to more skilled jobs and better working conditions. Students of industrial technology such as Woodward (1965) argued that assembly line work, which often appeared to reduce skill requirements, was only a stop on the road toward automated, "continuous production" factories where workers would be freed from machine-paced tasks. Blauner (1964) argued that such technologies would actually lead to an increase in skill, for example, as workers performed a broader range of monitoring tasks. This thesis reaches its high point with Bell's (1973) arguments that knowledge-based jobs would replace production work in the economy of the future.

[2] Adam Smith's (1776) observations about the increasing division of labor and the narrowing of jobs that results can also be seen as part of the beginning of the deskilling argument. It was developed by Durkheim (1964), Veblin (1914) and others who were concerned about the dehumanizing effects of automation and factory production and the broader effects it would have on society. The rise of scientific management as a theoretical argument for deskilling and of assembly line production methods in basic industries led to widespread acceptance of the deskilling argument supported by research findings (Walker and Guest 1952; Bright 1966) and to a shift in research to examine the *consequences* of deskilled jobs (e.g., Blauner 1964).

[3] One important issue in this debate is just how much of the system represents strategic decisions by management—decisions that were within their control—and how much was driven by economic forces and efficiency needs. Marglin and others in this tradition argue that the factory system *per se* was the product of a management strategy, although it is not necessary to go that far to argue that management pursued deskilling strategies when they were not necessarily efficient in a purely technological sense.

[4] In particular, Braverman argued that the shift in the distribution of occupations toward administrative and white collar jobs was not an indication that overall skill levels are rising, but instead was simply a manifestation of deskilled production work where the "mental" aspects had been removed.

[5] Most of these studies are cases, and many are historical. Hobsbawm (1964) describes, for example, how craft workers were able to use the techniques of organized labor (e.g., controlling supply) to resist management efforts to deskill jobs. Edwards, Reich, and Gordon (1979) suggest that changes in skill have been the result of a complex process of bargaining between management and labor. Other authors point to a range of environmental factors, such as product and labor market conditions, payment systems, management characteristics, and so forth, as helping to determine changes in skill (e.g., the papers in Wood 1982). Flynn's (1988) survey of hundreds of case studies of technological change finds considerable variance in the effects on employment and skill levels, lending support to the "mixed effects" hypothesis.

[6] Other studies in this period continued to emphasize the relationship between technology and skill. Hirshhorn (1984) suggests an argument similar to Bell's (1973) that new automated technologies will require higher-order mental and social skills from workers. On the deskilling side, some studies of the introduction of numerically controlled production machinery have suggested that the introduction of these machines is designed to reduce worker's skill (Noble 1977). Further, even where the mix of skills associated with numerically controlled jobs appears to grow, the changes may simply add more boring tasks and leave the content of the jobs degraded (Adler 1986). Again, studies in the "mixed result/it depends" tradition report a variety of changes in skill across situations, depending typically on contextual issues. (See the papers in Hyman and Streek [1988] and Zuboff [1988] for case-based examples and Kelley [1989] for a survey-based argument.) Overall, a National Academy of Sciences study (Cyert and Mowery 1987) concluded that changing technology was unlikely to increase skill requirements during the immediate future. (See Levin and Rumberger [1990] for a similar conclusion.)

[7] Blackburn, Bloom, and Freeman (1990) find, however, that the returns to education have increased even for older cohorts whose educational experience predates the decline in quality described by Bishop (1989a). This suggests that such declines cannot be the complete explanation for rising returns to education.

[8] Blackburn and Neumark (1991), however, find that the increase in returns to education has occurred largely for workers with higher levels of ability (measured by test scores), which is consistent with the hypothesis of increasing demand for workers with high levels of both basic capabilities and skills.

[9] Presumably, the incentives to increase the supply of applicants by deskilling jobs are always present, but whether the costs offset the gains depend on the cost of capital and the relative wages for higher skill. The rising wage differentials associated with skill and education noted above suggest that deskilling must not be the dominant trend in the economy, although it may have be particularly important in some sectors and may in part offset what would otherwise be even greater increases in skill differentials.

[10] Establishments are resurveyed every three years, and the survey data go back for nine years. The results are used to produce the *Occupational Outlook* handbooks for the BLS.

[11] The reliability of the *Occupational Employment Statistics Survey* (Bureau of Labor Statistics) also suffers from the fact that it is actually conducted separately by each state, under the general

guidance of, but not the control of, the BLS. The BLS takes the data from the states with little opportunity to check the reliability of the results or the methods used.

[12] The reliability tests appear to be qualitative—questioning "outliers," for example, or unusual patterns in the data.

[13] The incentives are clearly for Hay to be consistent over time in its methods. Long-term clients (the bulk of their business) know which of their jobs have remained constant, and it would be painfully obvious if Hay generated different job evaluations for those positions over time.

[14] The separate measures are combined through use of a constant algorithm that weights the various measures and creates an index from them. Unfortunately, only the final job evaluation total is available (measures of the separate components were not retained), and it is impossible to recreate the separate component scores from the aggregate score.

[15] The unit of analysis should be the individual job and the sample size should be the number of jobs in the sample because the individual job is where changes in skill requirements occur. Even in the most narrowly defined job family (Assembly Jobs), there may be many different and distinct jobs that are equal in value to a job title such as "Assembly Level 10." Workers who assemble ignition systems and those assembling engine valves may both have an "Assembly 10" title; the functions are not identical even though the skill requirements are the same. Even on a large-scale assembly line, it is very rarely the case that any two workers perform exactly identical tasks. And when there are changes in jobs, such as when new technology is introduced, it is certainly possible for changes to affect one worker and one function at a time; a new machine may change the assembly of ignitions without changing valve assembly. This is perhaps most obviously the case with clerical jobs, such as secretarial work, where even in the same office, the skill requirements of secretarial jobs may change on an individual basis depending on the kind of office equipment introduced at that station, the skills and demands of those served by the secretaries (whether they do their own word processing, for example), and so forth.

[16] The fact that word processors as machines are more complicated than typewriters does not mean that the function has gotten more complicated. Word processors may in fact be one of the clearest example of deskilling in that each function of the machine now performs tasks (such as pagination) that had been a discrete typist's skill.

[17] The precise effects on wage inequality depend, of course, on the shape of the distribution of the supply of workers by skill level and of the demand for such skill. Although assuming that supply and demand are initially in equilibrium for each job, an upward shift in the demand for skill will create disequilibrium at the lower tail of the distribution, where supply exceeds demand and wages must fall, and at the upper end, where demand exceeds supply and wages must rise. This holds for virtually all distributions.

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EQW APPENDICES

Appendices for the EQW WORKING PAPER:

Are Skill Requirements Rising? Evidence from Production and Clerical Jobs

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APPENDIX A

Hay Associates Guide Charts

FIGURE 1c Hay Guide Chart of Accountability

••• IMPACT OF JOB ON END RESULTS

INDIRECT
- REMOTE: Informational, recording, or incidental services for use by others in relation to some important end result.
- CONTRIBUTORY: Interpretive, advisory, or facilitating services for use by others in taking action.

DIRECT
- SHARED: Participating with others (except own subordinates and superiors), within or outside the organizational unit, in taking action.
- PRIMARY: Controlling impact on end results, where shared accountability of others is subordinate.

AMI for use with 1980 dollars is 245 — AMI EQUIVALENT

••• MAGNITUDE →	(1) VERY SMALL OR INDETERMINATE Under $100M				(2) SMALL $100M - $1MM				(3) MEDIUM $1MM - $10MM		
•• IMPACT →	R	C	S	P	R	C	S	P	R	C	S
FREEDOM TO ACT											
A. PRESCRIBED. These jobs are subject to: Direct and detailed instructions; Close supervision	10	14	19	25	14	19	25	33	19	25	33
	12	16	22	29	16	22	29	38	22	29	38
	14	19	25	33	19	25	33	43	25	33	43
B. CONTROLLED. These jobs are subject to: Instructions and established work routines; Close supervision	16	22	29	38	22	29	38	50	29	38	50
	19	25	33	43	25	33	43	57	33	43	57
	22	29	38	50	29	38	50	66	38	50	66
C. STANDARDIZED. These jobs are subject, wholly or in part, to: Standardized practices and procedures; General work instructions; Supervision of progress and results	25	33	43	57	33	43	57	76	43	57	76
	29	38	50	66	38	50	66	87	50	66	87
	33	43	57	76	43	57	71	100	57	76	100
D. GENERALLY REGULATED. These jobs are subject, wholly or in part, to: Practices and procedures covered by precedents or well-defined policy; Supervisory review	38	50	66	87	50	66	87	115	66	87	115
	43	57	76	100	57	76	100	132	76	100	132
	50	66	87	115	66	87	115	152	87	115	152
E. DIRECTED. These jobs, by their nature or size, are subject to: Broad practices and procedures covered by functional precedents and policies; Achievement of a circumscribed operational activity; Managerial direction	57	76	100	132	76	100	132	175	100	132	175
	66	87	115	11 /	87	115	152	200	115	152	200
	76	100	122	17.	100	132	175	230	132	175	230
F. ORIENTED DIRECTION. These jobs, by their nature or size, are broadly subject to: Functional policies and goals; General managerial direction	87	115	152	200	115	152	200	264	152	200	264
	100	132	175	230	132	175	230	304	175	230	304
	115	152	200	264	152	200	264	350	200	264	350
G. BROAD GUIDANCE. These jobs are inherently subject only to broad policy and general management guidance.	132	175	230	304	175	230	304	400	230	304	400
	152	200	264	350	200	264	350	460	264	350	460
	175	230	304	400	230	304	400	528	304	400	528
H. STRATEGIC GUIDANCE. These jobs, by reason of their size, independent complexity and high degree of effect on Company results, are subject [illegible] from top management.	200	264	350	460	264	350	460	608	350	460	608
	230	304	400	528	304	400	528	700	400	528	700
	264	350	460	608	350	460	608	800	460	608	800
	304	400	528	[illegible]	[illegible]	575	700	800	528	700	[illegible]

	I. MINIMAL			II. RELATED			III. DIVERSE		
	1	2	3	1	2	3	1	2	3
A. BASIC	50 57 66	57 66 76	66 76 87	66 76 87	76 87 100	87 100 115	87 100 115	100 115 132	115 132 152
B. ELEMENTARY VOCATIONAL	66 76 87	76 87 100	87 100 115	87 100 115	100 115 132	115 132 152	115 132 152	132 152 175	152 175 200
C. VOCATIONAL	87 100 115	100 115 132	115 132 152	115 132 152	132 152 175	152 175 200	152 175 200	175 200 230	200 230 264
D. ADVANCED VOCATIONAL	115 132 152	132 152 175	152 175 200	152 175 200	175 200 230	200 230 264	200 230 264	230 264 304	264 304 350
E. BASIC TECHNICAL - SPECIALIZED	152 175 200	175 200 230	200 230 264	200 230 264	230 264 304	264 304 350	264 304 350	304 350 400	350 400 460
F. SEASONED TECHNICAL - SPECIALIZED	200 230 264	230 264 304	264 304 350	264 304 350	304 350 400	350 400 460	350 400 460	400 460 528	460 528 608
G. TECHNICAL - SPECIALIZED MASTERY	264	304	350	350	400	460	460	528	608 700

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FIGURE 1b Hay Guide Chart of Problem Solving

	1. REPETITIVE	2. PATTERNED	3. INTERPOLATIVE	4. ADAPTIVE
A. STRICT ROUTINE	10% 12%	14% 16%	19% 22%	25% 29
B. ROUTINE	12% 14%	16% 19%	22% 25%	29% 33%
C. SEMI-ROUTINE	14% 16%	19% 22%	25% 29%	33% 38%
D. STANDARDIZED	16% 19%	22% 25%	29% 33%	38% 43%
E. CLEARLY DEFINED	19% 22%	25% 29%	33% 38%	43% 50%
F. BROADLY DEFINED	22% 25%	29% 33%	38% 43%	50% 57%
G. GENERALLY DEFINED	25% 29%	33% 38%	43% 50%	57% 66%
H. ABSTRACTLY DEFINED	29%	38%	50%	66%

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APPENDIX B

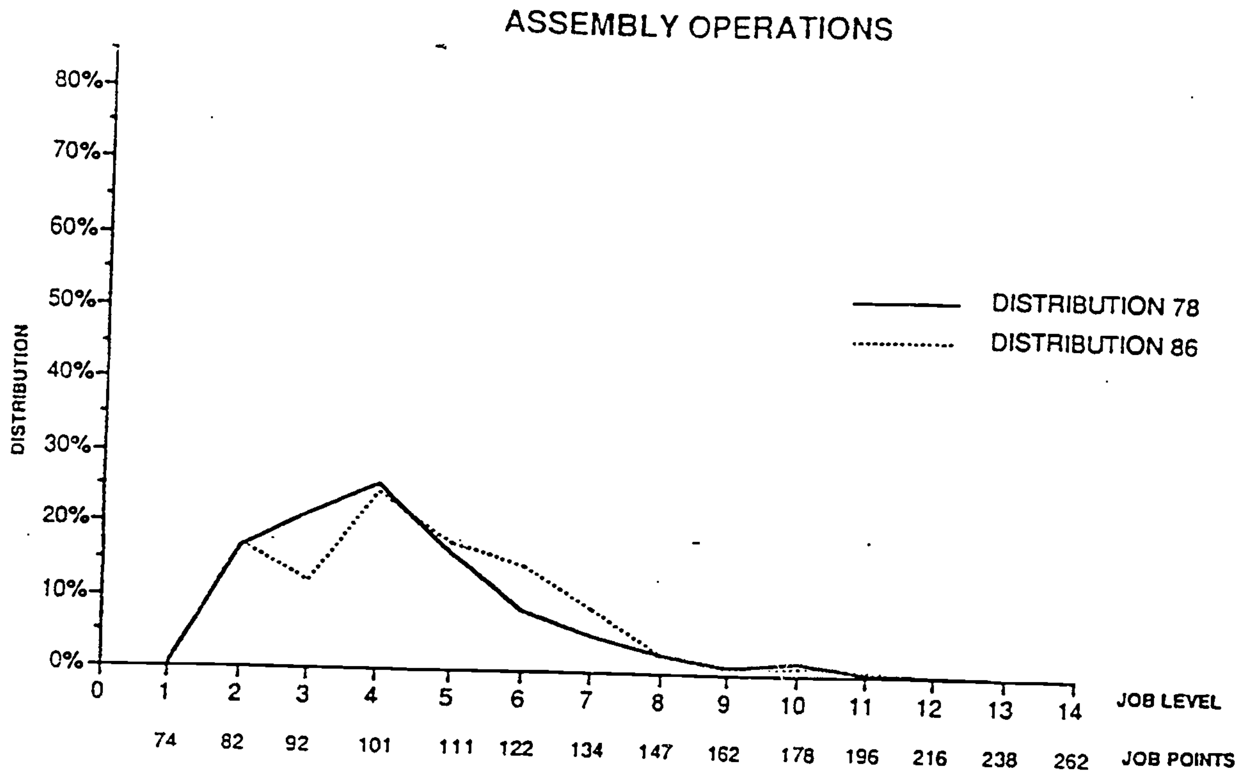
Production Job Titles

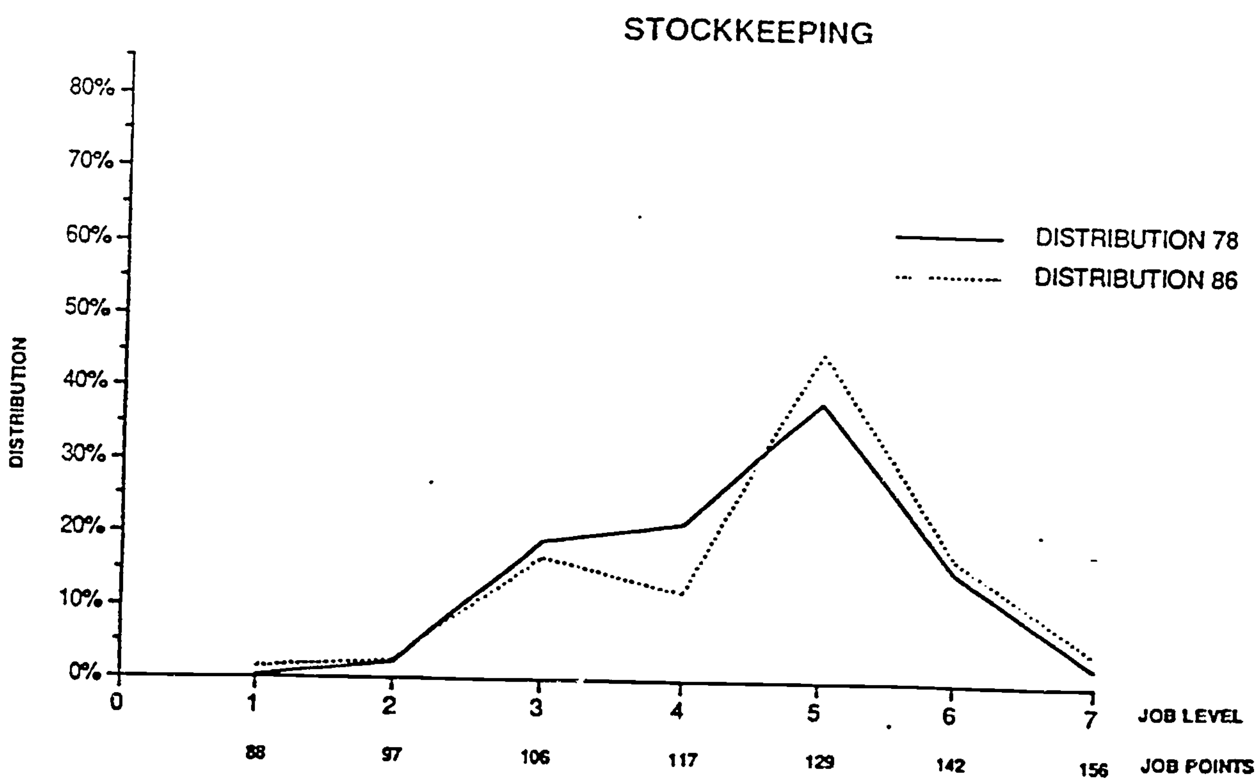
PRODUCTION POSITIONS

(Ranked from lowest to highest evaluation)

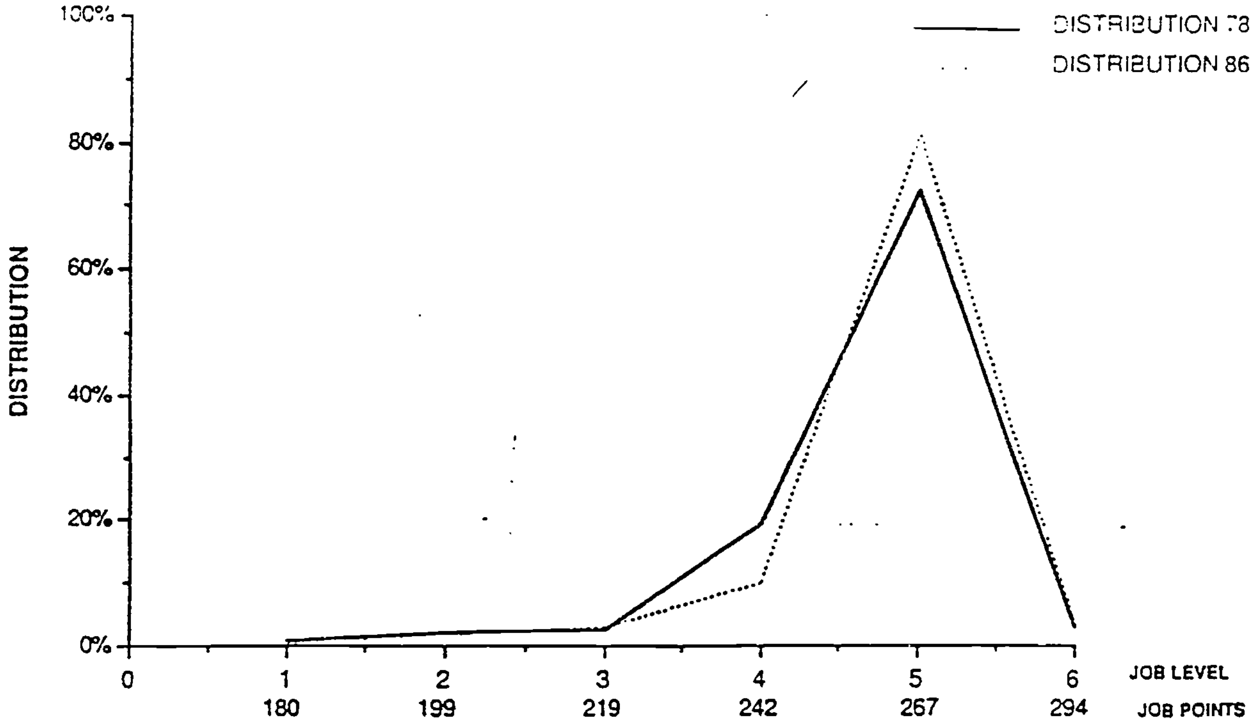
Job Content Group	Job No.	Evaluation Grade	Avg. Survey Pts.
1	35 49	Assembler 1 Inspection 1	76
2	15	Material Handling 1	80
3	1 24 36 50	Housekeeping 1 Processing 1 Assembler 2 Inspection 2	84
4	8 16	Stockkeeping 1 Material Handling 2	88
5	2 25 37 63 51	Housekeeping 2 Processing 2 Assembler 3 Machining Operations 1 Inspection 3	92
6	9 17	Stockkeeping 2 Material Handling 3	97
7	3 26 38 64 52	Housekeeping 3 Processing 3 Assembler 4 Machining Operations 2 Inspection 4	101
8	10 18	Stockkeeping 3 Material Handling 4	107
9	4 27 39 65 53	Housekeeping 4 Processing 4 Assembler 5 Machining Operations 3 Inspection 5	111
10	11 19	Stockkeeping 4 Material Handling 5	118
11	5 28 40 66 54	Housekeeping 5 Processing 5 Assembler 6 Machining Operations 4 Inspection 6	122
12	12 20	Stockkeeping 5 Material Handling 6	130
13	6 29 41 67 55	Housekeeping 6 Processing 6 Assembler 7 Machining Operations 5 Inspection 7	134
14	13 21	Stockkeeping 6 Material Handling 7	143
15	7 30 42 68 75 56	Housekeeping 7 Processing 7 Assembler 8 Machining Operations 6 Machine Repair 1 Inspection 8	147

Job Content Group	Job No.	Evaluation Guide	Avg. Surve Pts.
16	14 22	Stockkeeping 7 Material Handling 8	157
17	31 43 69 76 57	Processing 8 Assembler 9 Machining Operations 7 Machine Repair 2 Inspection 9	162
18	23	Material Handling 9	172
19	32 44 70 77 58 89	Processing 9 Assembler 10 Machining Operations 8 Machine Repair 3 Inspection 10 Tool & Die 1	179
21	83	Electrician 1	184
23	33 45 71 78 59 90	Processing 10 Assembler 11 Machining Operations 9 Machine Repair 4 Inspection 11 Tool & Die 2	198
24	84	Electrician 2	203
26	34 46 72 79 60 91	Processing 11 Assembler 12 Machining Operations 10 Machine Repair 5 Inspection 12 Tool & Die 3	219
27	85	Electrician 3	224
29	47 73 80 61 92	Assembler 13 Machining Operations 11 Machine Repair 6 Inspection 13 Tool & Die 4	242
30	86	Electrician 4	247
32	62 48 74 81 93	Inspection 14 Assembler 14 Machining Operations 12 Machine Repair 7 Tool & Die 5	267
33	87	Electrician 5	272
35	82 94	Machine Repair 8 Tool & Die 6	294
36	88	Electrician 6	299

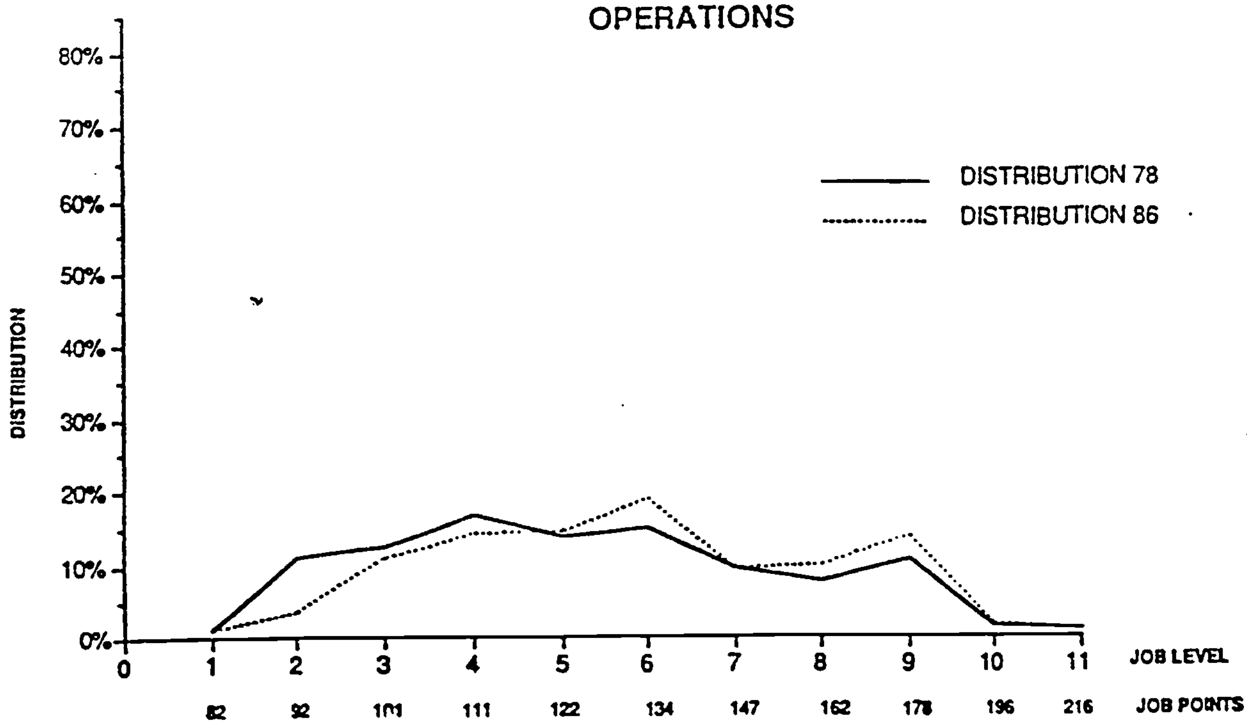

ASSEMBLY OPERATIONS
80%
70%
60%
50%
40%
30%
20%
10%
0%
DISTRIBUTION
DISTRIBUTION 78
DISTRIBUTION 86
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
JOB LEVEL
74 82 92 101 111 122 134 147 162 178 196 216 238 262
JOB POINTS

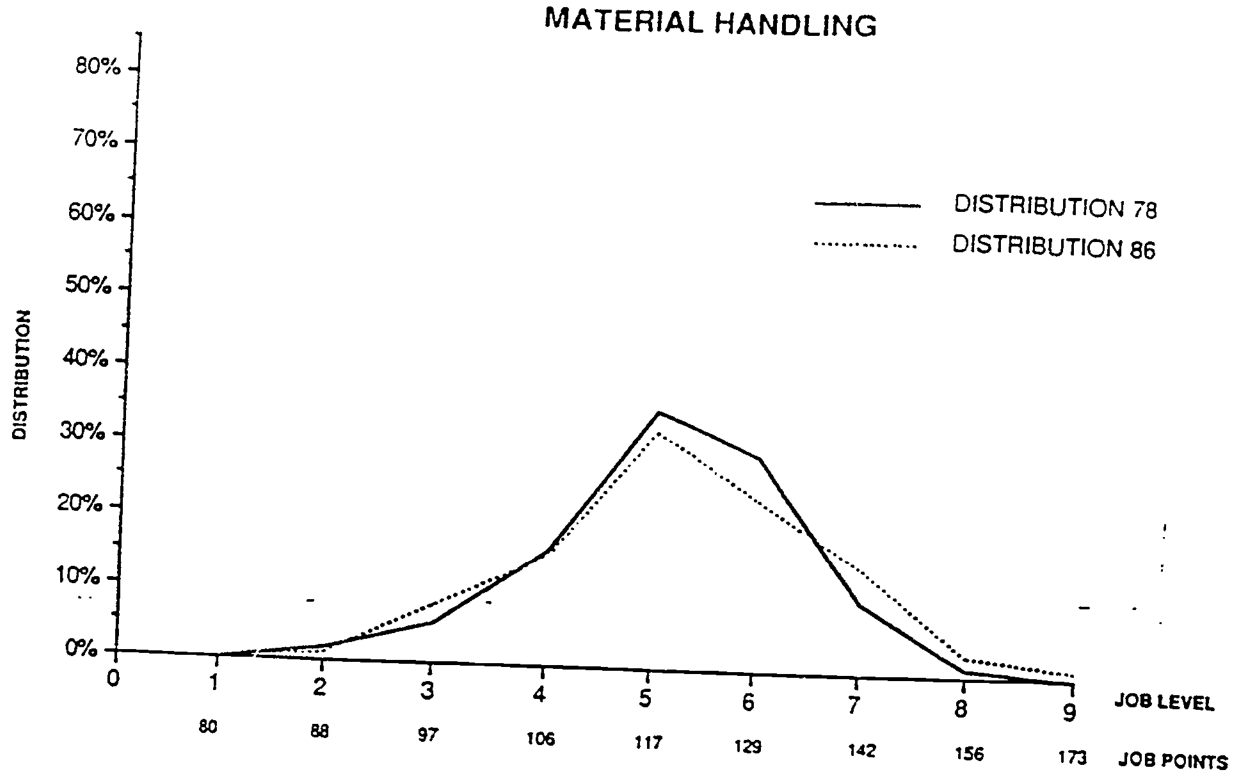

STOCKKEEPING
80%
70%
60%
50%
40%
30%
20%
10%
0%
DISTRIBUTION
DISTRIBUTION 78
DISTRIBUTION 86
0 1 2 3 4 5 6 7
JOB LEVEL
88 97 106 117 129 142 156
JOB POINTS

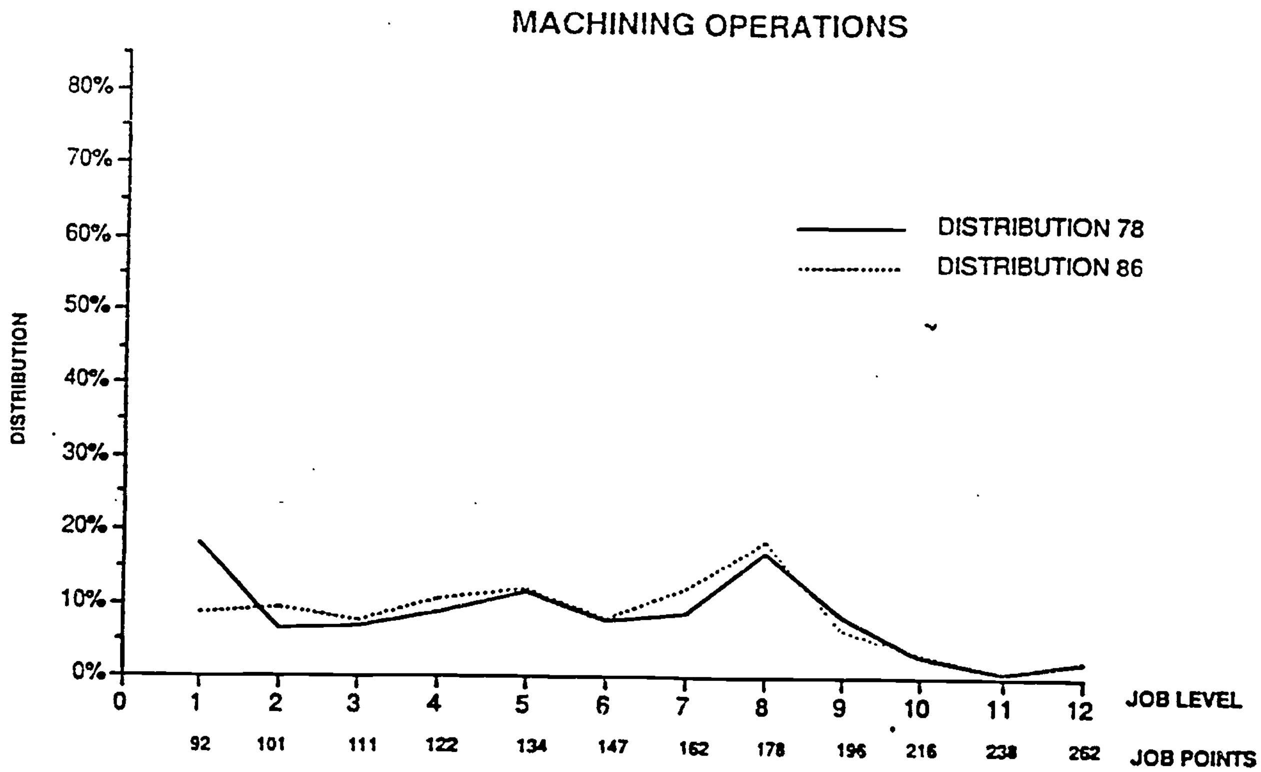
TOOL & DIE WORK

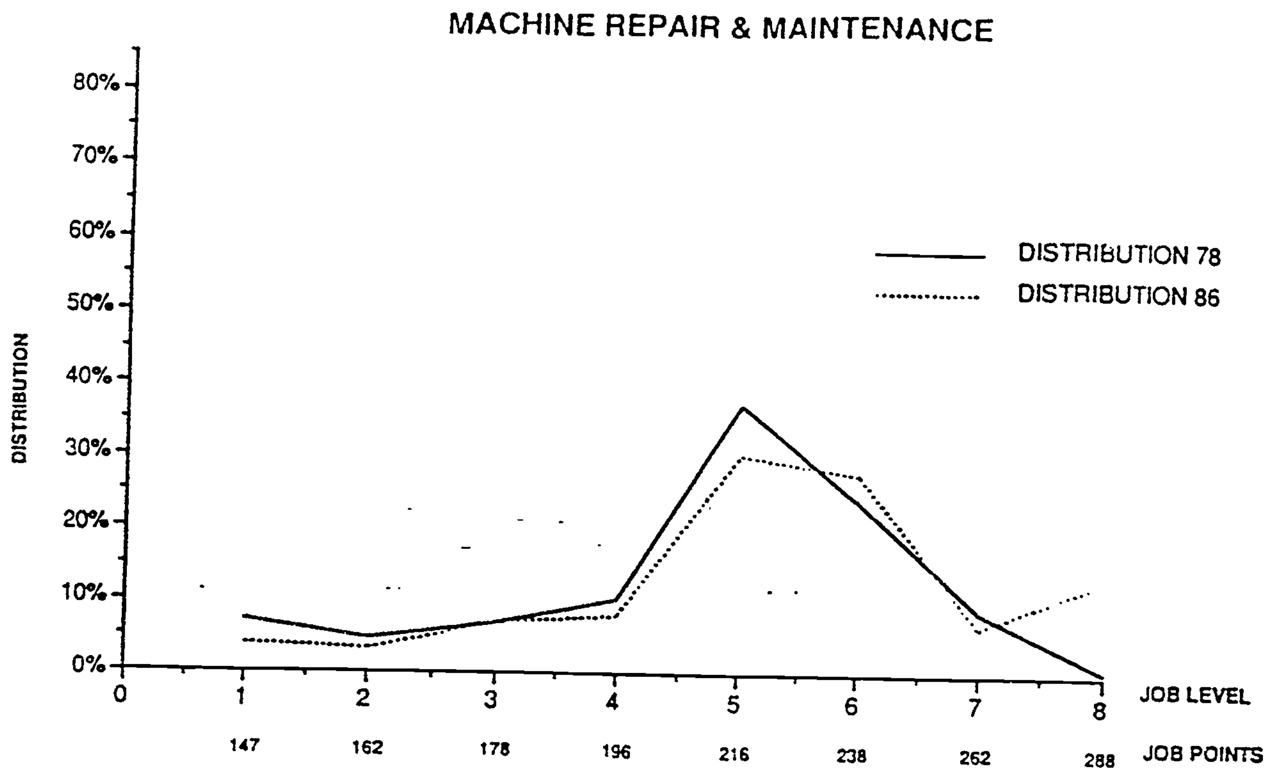


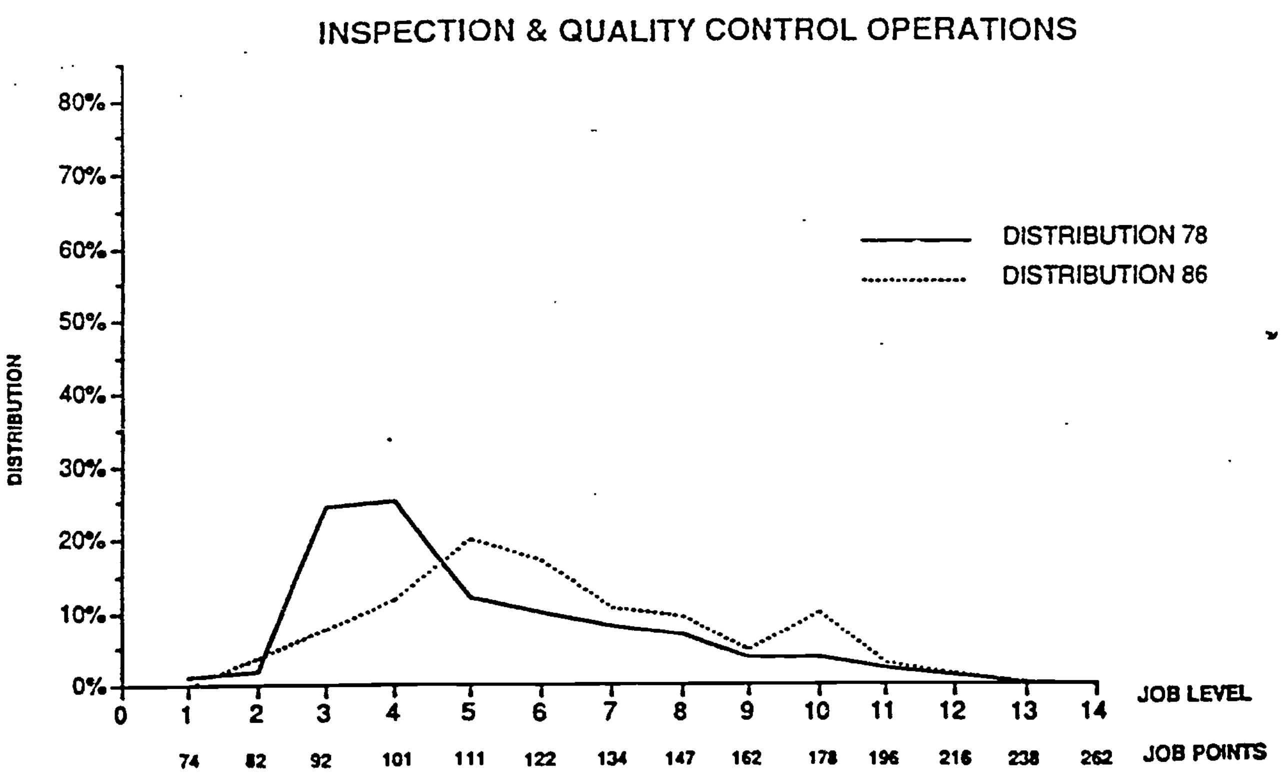
PROCESSING OPERATIONS




MATERIAL HANDLING
80%
70%
60%
50%
40%
30%
20%
10%
0%
DISTRIBUTION
DISTRIBUTION 78
DISTRIBUTION 86
0 1 2 3 4 5 6 7 8 9
JOB LEVEL
80 88 97 106 117 129 142 156 173
JOB POINTS


MACHINING OPERATIONS
80%
70%
60%
50%
40%
30%
20%
10%
0%
DISTRIBUTION
DISTRIBUTION 78
DISTRIBUTION 86
0 1 2 3 4 5 6 7 8 9 10 11 12
JOB LEVEL
92 101 111 122 134 147 162 178 196 216 238 262
JOB POINTS


MACHINE REPAIR & MAINTENANCE
80%
70%
60%
50%
40%
30%
20%
10%
0%
DISTRIBUTION
DISTRIBUTION 78
DISTRIBUTION 86
0
1
2
3
4
5
6
7
8
JOB LEVEL
147
162
178
196
216
238
262
288
JOB POINTS


INSPECTION & QUALITY CONTROL OPERATIONS
80%
70%
60%
50%
40%
30%
20%
10%
0%
DISTRIBUTION
DISTRIBUTION 78
DISTRIBUTION 86
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
JOB LEVEL
74
82
92
101
111
122
134
147
162
178
196
216
238
262
JOB POINTS